NOTES ON THE OSTEOLOGY OF THE PARIDÆ, SITTA, AND CHAMÆA.

BY

FREDERIC A. LUCAS,

Assistant Curator of the Department of Comparative Anatomy.

(With Plate XXVII).

In studying any group of oscinine birds it is impossible, or at the best extremely difficult, to tell where to stop, and the question is quite as often decided by the lack of material as by any other cause.

Thus the present paper is the outcome of a study of the *Mimina*, which naturally included the Wrens also, and from them led by way of *Chamæa* to the Titmice, and but for the cause above mentioned might be indefinitely extended.

Dealing chiefly with North American species these notes are naturally incomplete; but, as the accumulation, proper preparation, and study of osteological material are necessarily slow, they are put forth with an apology for not being more comparative in their nature.

I give below a list of the species examined and all references to the *Paridæ* mean the group as thus represented.

Parus major	Parus inornatus
ater	gambeli
carolinensis	Psaltriparus plumbeus
atricapillus	minimus
montanus	Auriparus flaviceps
hudsonicus	Ægithalus caudatus
cæruleus	Chamæa fasciata
bicolor	Sitta canadensis.

The above are all represented in the collections of the U. S. Museum, but I am indebted to Dr. R. W. Shufeldt for the privilege of examining a large number of specimens in his collection.

In the genus *Parus*, as here represented, the brain case is large, the beak short, stout, and conical.

The interorbital septum is well ossified up to the point of exit of the olfactory nerves, although small perforations may be present in the septum, as in *Parus bicolor*, *hudsonicus*, *gambeli*, and *inornatus*.

The vacuity in the skull at the point of exit of the olfactory nerves is small; much larger in *P. hudsonicus* than in any other species examined.

The premaxillaries and nasals fuse early in life, and are cut squarely across at their posterior extremities, where they are movably articulated with the frontals, as in parrots, the maxillary being also movably articulated with the premaxillary.

The narial openings are small, a short ellipse in shape, with the external process of the nasal continued but a short distance along the premaxillary.

The transpalatines are subacuminate and, as well as the postpalatines, much produced downward and slightly backward.

The prepalatines are moderately stout and seem to increase in width with age.

The manner in which the palatines join the premaxillaries can be seen only in rather young birds, for, with age, ossification invades the membranous anterior portion of the palatal region, not only conceal ing the terminations of the palatines, but forming a line across them that so strikingly simulates a suture as to have deceived not only the writer, but so keen an observer as Dr. Parker, who has figured this groove as a suture.

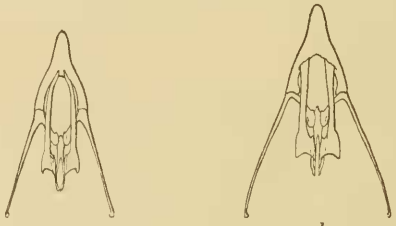


FIG. 1.—*a*, palatal region of a rather young specimen of *Parus hudsonicus*, showing the anterior ends of the palatines; *b*, palatal region of an old specimen of *Parus bicolor*, with the anterior ends of the palatines fused with the premaxillaries. Both figures enlarged.

The mandible has a large elliptical perforation, and there are two mandibular sesamoids, one behind and one at the outer side of the articulation.

In *Parus bicolor* the vertebral arteries enter the cranium a little above the foramen magnum, while in the other members of the genus *Parus* these arteries pierce the skull right on the edge of the foramen.

Except in this slight particular, I find no difference between *P. bicolor* and its near relatives.

In the skull of *Auriparus* we meet with a departure from that of *Parus* in the open orbital septum, this consisting of a very slender bar of bone; otherwise the skulls of the two genera are very similar in structure.

The mandibular perforation of *Auriparus* is very small.

In *Egithalus* the interorbital septum is a slender bar, there is no cranio facial hinge, the maxillary and premaxillary are fused, and the vacuity at the exit of the olfactory nerves is large.

The general aspect of the cranium, however, is Parine in spite of the peculiar curve of the beak; the narial opening are small ellipses; the external process of the nasal is continued but a short distance along the premaxillary, and the prepalatine bars are broad, although they join the premaxillaries in a slightly different manner than in *Parus*.

Psaltriparus has scarcely a cranial character in common with other *Paridæ*, the interorbital septum being open and the vacuity at the exit of the olfactory nerves large, while there is no maxillo-premaxillary nor cranio-facial hinge, the nasals overlapping the frontals for a considerable portion of their extent.

The narial openings are large, elongate ellipses, although the external process of the nasal is continued but a moderate distance along the premaxillary; the prepalatines, which are narrow rods, are for some distance in contact with the premaxillaries and the trans and postpalatine processes are slightly different in shape and arrangement from what is found in other *Paridæ*.

In short, judging from the cranium alone, *Psaltriparus* would scarcely be considered a Tit at all.

The maxillo-palatines are more slender and less pneumatic in *Psaltriparus* than in other members of the group, but with that exception these little processes seem to be uniform in pattern throughout the various species, although I am unable to speak as positively on this point as I would like.

In a previous paper it was noted that the anterior termination of the vomer was subject to great specific variation, and in this respect the *Paridæ* are truly remarkable, the vomer varying from sharply spear-shaped in *Parus inornatus griseus* to abruptly truncate in *Parus carolinensis*.

Anterior end of vomer of—

Parus major

ater

carolinensis

montanus

hudsonicus

cæruleus

bicolor

inornatus

Egithalus caudatus

Chamæa fasciata

FIG. 2.—All the above are enlarged and drawn to the same absolute scale.

The thoracic skeleton of the *Paridæ* bears the same stout, compact character that is seen in the external appearance of this group of birds, the chest cavity being deep, the sternum of good size and well keeled.

The sternum flares considerably posteriorly and the costal processes are high, acuminate, and directed well forward, their shape being practically the same throughout the group.

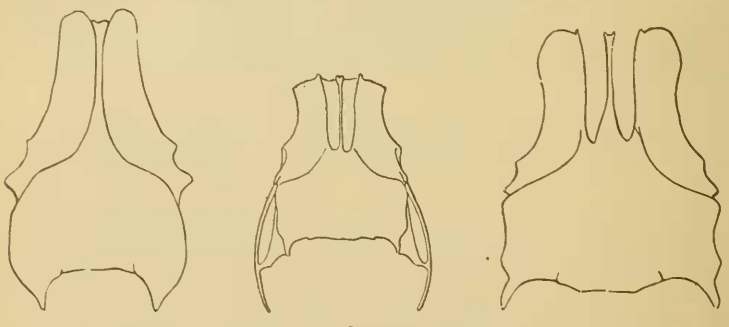
The varying pneumaticity of the sternum will be treated of further on, but it may be noted that when this bone is pneumatic there is a single opening in the dorsal aspect of the sternum just above the anterior origin of the keel.

The coracoids possess a moderate flange, or ridge, running from the epicoracoid about half way up the shaft, but it is by no means so well developed as in the Thrushes, where this character appears to be carried to its extreme.

The hypocleidium is long, slender, and bent upward much as in the Wrens.

The scapula is stout and regularly curved downward for its distal half, the various species examined being unusually uniform in respect to the shape of this very variable bone.

The dorsal aspect of the pelvis, which is constant in shape throughout the group, so far as examined, can be better understood from the accompanying figure than from any detailed description.



a *b* *c*

FIG. 3.—*a*, pelvis of *Campylorhynchus affinis*; *b*, pelvis of *Parus bicolor*; *c*, pelvis of *Merula migratoria*.

In general pattern it very closely resembles that of the Thrushes, the posterior portion in particular being characterized by the breadth and squareness so marked in that group of birds.

The ilio-neural grooves are open, and the obturator foramen is separated by a considerable bar of bone from the obturator space.

The "sacrum" is wide, more or less keeled and deeply pitted, the pits seemingly marking the intercentral spaces.

If I am correct in my count the following species have the "sacrum" composed of five presacrals, two sacrals, and five caudals: *Parus ater*, *P. carolinensis*, *P. montanus*, *P. hudsonicus*, *P. cæruleus*, *P. bicolor*, *Auriparus flaviceps*, *Ægithalus caudatus*.

The only specimen of *Parus major* at hand appears to have but *four* presacrals, two sacrals, and *four* caudals, but there is an abnormal look about this sacrum, and there seems to be a little uncertainty (if the

term is allowable) in the development of the sacral parapohyses in the various species.

FIG. 4.—Composite sacrum of *Parus carolinensis*, the right and left halves being from two individuals. Enlarged. The difference between the last two presacrals of either side should be noted, as well as the fact that there is one more parapophysis on the left half of the figure than on the right.

The species in hand have each six free caudals and a pygostyle, with the exception of *Egithalus*, which has seven caudals and a pygostyle.

The fore and hind limbs are respectively made on the same plan throughout the group, and there is little to be said regarding them.

The following table shows the pneumatic or non-pneumatic condition of the sternum and humerus in the various species examined, the two species of *Polioptila* being introduced to show that variation in this respect may occur in closely related species.

The columns headed above and below denote that the pneumatic foramina are respectively above or below the septum dividing the pneumatic fossa, and in two cases it will be seen that foramina exist on both sides of the septum, the opening above being much the larger.

	Sternum.		Humerus.			
	Pneumatic.	Non-pneumatic.	Pneumatic.	Non-pneumatic.	Above.	Below.
Parus major	×		×		×	
ater	×		×			×
carolinensis	×		×		×	
atricapillus		×	×			×
montanus	×		×		×	
hudsonicus		×		×		
cæruleus		×		×		
bicolor	×		×			×
inornatus	×		×		×	×
gambeli	×		×		×	×
Psaltriparus plumbeus		×		×		
minimus		×		×		
Auriparus flavi ceps		×		×		
Ægithalus caudatus		×		×		
Chamæa fasciata		×		×		
Sitta canadensis		×		×		
Polioptila plumbea		×		×		
cærulea		×	×			×

This table shows that the larger Titmice usually, although not always, have a pneumatic sternum and humerus, while in the smaller species these bones are non-pneumatic. It also shows that, while a pneumatic sternum is usually correlated with a pneumatic humerus and

a non-pneumatic sternum with a non-pneumatic humerus, exceptions to this are by no means rare, and that the character is of little taxonomic value.

To briefly sum up, the family *Paridæ* as it now stands comprises birds differing very decidedly in cranial character, and while the genera *Parus*, *Auriparus*, *Ægithalus*, and *Psaltriparus* may be craniologically diagnosed, I confess my inability to assign osteological characters to the group.

That the group is not a natural one I should hesitate to assert, but it is by no means so homogeneous as the Swallows, Wrens, or Thrushes, so far as I have studied them.

The genus *Sitta* is sometimes placed among the *Paridæ*, but, taking *Sitta carolinensis* as a typical member of the genus, it differs from the Titmice and especially from *Parus* in many important particulars.

The skull of *Sitta* resembles that of *Parus* in having a nearly closed interorbital septum and broad prepalatines. On the other hand, the skull of *Sitta* is slightly depressed instead of elevated, there is no fronto-nasal nor maxillo-premaxillary hinge, the narial openings are elongate ellipses, the nasals are very peculiar in form, with the external process carried for a considerable distance along the premaxillary, and the transpalatines and postpalatines are but slightly bent downward.

The prepalatines of *Sitta* too overlie and fuse with the premaxillaries, while in the *Paridæ* the prepalatines run along the inner edge of the premaxillaries and the bones are soldered together by the deposition of osseous matter in the surrounding membrane.

Sitta also has what is unusual in the smaller Passeres, a large, free lachrymal, much as in the *Corvidæ*, and the quadrate is so compressed vertically that the pterygoid lies immediately under, and almost in contact with, the ascending process, as in the *Caprimulgidæ*.

The pelvis of *Sitta* is anteriorly much narrower than in any of the *Paridæ*, the ischium and pubis project farther downward and backward than in this group, and the obturator foramen is connected with the very large obturator space.

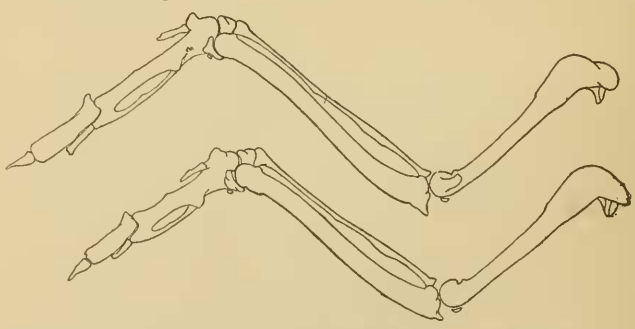


FIG. 5.—Dorsal aspect of left wings of *Sitta carolinensis* and *Parus bicolor*. Enlarged.

Sitta, moreover, is peculiar in having—compared with the humerus—a somewhat elongate fore arm and manus, differing in this respect from the Tits, and very much resembling the *Corvidæ*.

The tibia of *Sitta* is characterized by the curious shape of its proximal portion, where it is thin and bent inward; but as something very similar occurs in *Certhia* this would seem to be a teleological modification from climbing.

The tibia is also proportionately shorter in *Sitta* than in *Paridæ*, while the first phalanx of the first digit is remarkably long.

Taking all skeletal characters into consideration, the differences between *Sitta* and the *Paridæ* are such as would seem to preclude their being grouped together, while the peculiarities in the wing of *Sitta*, slight as they may appear, when added to the other characters, seem sufficient to warrant the assignment of the genus to a separate family.

At the same time I wish to qualify this by saying that until more species of the genus and those genera apparently allied to it have been worked out the matter cannot be considered as settled.

The last form to be considered in this paper is *Chamæa*.

This genus was placed by Sundevall in his group *Toxostominæ* next to *Galeoscoptes*, and in Gray's Hand List stands as a family between *Paridæ* and *Muiotiltidæ*.

Professor Baird in the Birds of North America makes *Chamæinæ* a subfamily of Wrens and in his Review of American Birds elevates it to family rank between *Paridæ* and *Sylvicolidæ*, with the remark that "it may properly belong to some Old World group."

Dr. Coues, in the Key to North American Birds, puts the family *Chamæidæ* between *Sylviidæ* and *Paridæ*, adding that it may be placed with the *Timeliidæ* as justly as many other forms.

Mr. Sharpe, in the British Museum Catalogue of Birds, Vol. VII, creates the group *Chamææ* in the family *Timeliidæ*, the Wrens also being relegated to this family. He says:

> The curious little bird which forms the single representative of the present group possesses characters which seem to ally it to several other groups; and it is not surprising that it has been considered by Professor Baird to belong to a separate family, *Chamæadæ*. The wing is essentially Timeliine, being concave and rounded, with a large first primary; the legs, too, are strong; but in other respects the general aspect of the bird is Titlike, and Professor Baird places it in close proximity to the Tits in his "Review."

In the A. O. U. Check List *Chamæa* appears with other genera in a subfamily (*Chamæinæ*) of *Paridæ*, and in Ridgway's Manual of North American Birds it also figures under *Paridæ*, but with the following note:

> I have been obliged to assign different limits to the subfamilies *Parinæ* and *Chamæinæ* from those given in the A. O. U. Check List, on account of the impossibility of giving characters which would cover the extremely different genera there inadvertently placed under *Chamæinæ*. The latter properly includes only *Chamæa*; and it is extremely doubtful whether this genus has any real affinity with the *Paridæ*, its relationship being probably much nearer to the *Troglodytidæ*.

In the Standard Natural History, Mr. Stejneger is "most inclined to regard the *Chamæinæ* only as a subfamily of the Wrens," and my own

expressed opinion was that *Chamæa* appeared "most decidedly to belong with the Wrens, and not with the Titmice."

Finally, Dr. Shufeldt, in a paper in the Journal of Morphology, says that, "so far as its topographical anatomy and characters are concerned, *Chamæa* shows a far closer kinship with *Psaltriparus* than it does with any of our typical North American Wrens."

Craniologically *Chamæa* is much like *Psaltriparus*, and in those points in which *Psaltriparus* differs from *Parus*, by just so much does it approach *Chamæa*.

This bird has an open interorbital septum, a large cardiform vacuity at the exit of the olfactory nerves, no maxillo-premaxillary nor craniofacial hinge, elongate elliptical narial openings, and the external process of the nasal continued but a short distance along the premaxillary.

All these characters, save the last, are found in the Wrens as well as in *Psaltriparus*, and probably in numberless other Passeres and simply illustrate the great similarity of structure obtaining in the order.

In the Wrens, the external process of the nasal runs nearly the entire length of the narial opening, there is usually a small, laminar lachrymal present and the maxillo-palatines have a peculiar hamate form and are non-pneumatic.

In *Chamæa*, as in the *Paridæ*, the maxillo-palatines are pneumatic although the shape of these processes differs in the two groups.

The shoulder-girdle of *Chamæa* is extremely feeble, the keel of the sternum being lower than in *Psaltriparus minimus*, and the wing much shorter than in *Parus carolinensis*.

The distinctions between the shoulder-girdle of *Chamæa* and the Titmice are teleological rather than morphological, and this is equally true of the same parts in the Wrens and Titmice, the Wrens being narrow-chested weak-armed birds, while the Tits are sturdy, full chested, and strong armed.

Like the Wrens *Chamæa* has the ridge running upward from the epicoracoid almost obsolete, and this is a point of some value, its presence or absence apparently having nothing to do with power of flight.

The coracoid of *Chamæa* seems unusually long, but the length is apparent, and not real, being due to the small size of the associated parts.

The sacrum of *Chamæa*, like that of the *Paridæ*, is broad and deeply pitted, but here similarity between the pelvic girdles of the two ceases.

Viewed from above, the pelvis of *Chamæa* is anteriorly narrow and posteriorly contracted, as in Wrens, possessing the characteristic angular aspect peculiar to the pelvis of that group.

Viewed laterally the dorsal outline of the pelvis is alike decurved in *Chamæa* and the Wrens, the dorsal outline of the pelvis in the *Paridæ*—as in the Thrushes—being much straighter.

The renal fossæ in *Chamæa* are shaped as in the Wrens, being more sharply triangular than in the *Paridæ*.

In proportionate length of hind limb *Chamæa* surpasses any of the Wrens and greatly exceeds any Titmouse.

The tibia and tarsus of *Chamæa* are as long as the corresponding bones in *Campylorhynchus*, and but for the shorter femur of *Chamæa* the hind limbs of the two birds would be of the same length, although *Campylorhynchus* is almost one-half the longer of the two, and certainly four times as heavy.

In the arrangement of the phalangeal articular facets *Chamæa* is wren-like, the second and fourth being in the same plane, while in the *Paridæ* the second is above the fourth.

Chamæa is characterized by a considerable development of the procnemial ridge, this probably bearing some relation to its ground-haunting habits; still the amount of development of the pro and ectocnemial ridges is variable, both among the Wrens and Tits.

It appears, then, that in its cranial characters *Chamæa* is much like *Psaltriparus*, while the shoulder girdle is slightly and the pelvic girdle decidedly wrenlike.

Dr. Shufeldt's conclusion that *Chamæa* finds its nearest relative in *Psaltriparus* was therefore more correct than my own, that *Chamæa* belonged with the Wrens, and I can only say that at the time I ventured this opinion *Psaltriparus* was not available.

On the other hand, none of the characters shown in the skeleton of *Chamæa* seems sufficient to warrant placing the genus either with the Wrens or Tits, but rather bear out the intermediate position indicated in the name of Wren-Tit.

That *Chamæa* should show resemblances to or leanings toward more than one group of birds is not at all surprising, for, as Professor Newton most truly says:

> This last and highest group of birds (Oscines) is one which, as before hinted, it is is very hard to subdivide.
>
> Some two or three natural, because well differentiated, families are to be found in it. * * *
>
> But the great mass, comprehending incomparably the greatest number of genera and species of birds, defies any sure means of separation. Here and there, of course, a good many individual genera may be picked out capable of the most accurate definition, but genera like these are in the minority and most of the remainder present several apparent alliances from which we are at a loss to choose that which is nearest. * * * We may take examples in which what we may call the Thrush form, the Tree creeper form, the Finch form, or the Crow form is pushed to the most extreme point of differentiation, but we shall find that between the outposts thus established there exists a regular chain of intermediate stations so intimately connected that no precise lines of demarkation can be drawn cutting off one from the other."*

Limited as my studies of the skeletal characters of the Oscines have been they are sufficient to emphasize the above remarks, and it is probably not assuming too much to say that with a sufficiently large series of specimens any two oscinine birds may be osteologicaly linked together.

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* Art. Ornithology, Ency. Brit., IX, vol. XVIII, p. 47.